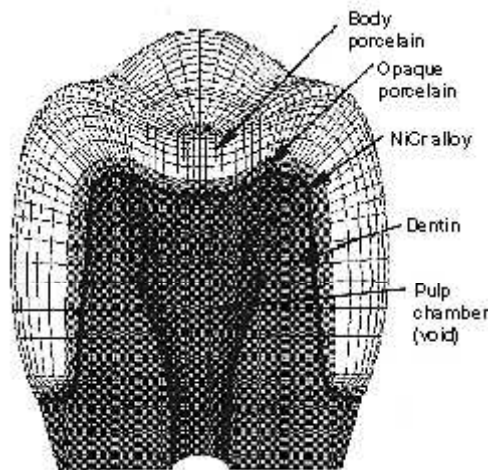


Award-Winning CARES/*Life* Ceramics Durability Evaluation Software Is Making Advanced Technology Accessible

Products made from advanced ceramics show great promise for revolutionizing aerospace and terrestrial propulsion and power generation. However, ceramic components are difficult to design because brittle materials in general have widely varying strength values. The CARES/*Life* software developed at the NASA Lewis Research Center eases this by providing a tool that uses probabilistic reliability analysis techniques to optimize the design and manufacture of brittle material components.

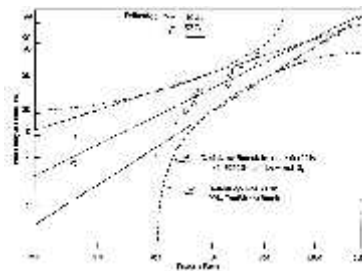
CARES/*Life* is an integrated package that predicts the probability of a monolithic ceramic component's failure as a function of its time in service. It couples commercial finite element programs--which resolve a component's temperature and stress distribution--with reliability evaluation and fracture mechanics routines for modeling strength-limiting defects. These routines are based on calculations of the probabilistic nature of the brittle material's strength.

The program has many features and options for materials evaluation and component design, and the capability, flexibility, and uniqueness of CARES/*Life* has attracted much interest. To maintain this interest as well as keep abreast of fast-changing operating systems and applications software, we have upgraded CARES/*Life* with graphic templates for common business presentation software such as Lotus Freelance Graphics. In addition, an interactive input preparation program has been prepared to guide users through various program control options and specific data input formats. A grinding damage module has been added to account for flaws introduced by finishing (grinding) operations and specimen rupture data. This grinding damage module, in conjunction with finite element analysis, can now be used to characterize the material fracture behavior.



Tilted view of a cross section and top of a finite element model of a porcelain-fused-to-metal molar crown analyzed with CARES/Life.

CARES/Life has been in high demand world-wide, although present technology transfer efforts are entirely focused on U.S.-based organizations. Success stories can be cited in numerous industrial sectors, including aerospace, automotive, biomedical, electronic, glass, nuclear, and conventional power-generation industries. In 1995, R&D Magazine gave a prestigious R&D 100 Award jointly to the NASA Lewis Research Center for development of CARES/Life and to Philips Display Components Company for applying this software to the design and manufacture of an improved television picture tube for the U.S. consumer market. The exceptional technical accomplishments and efforts of the CARES/Life development team were also recognized with NASA Lewis' 1995 Steven V. Szabo Engineering Excellence Award.



Sample output from CARES/Graphics. The ability to depict specimen rupture data (two-parameter Weibull data) by using common business presentation graphics packages significantly enhances the utility of CARES/Life for the design engineer.

Bibliography

Nemeth, N.N., et al.: Time-Dependent Reliability Analysis of Monolithic Ceramic Components Using the CARES/Life Integrated Design Program. Life Prediction Methodologies and Data for Ceramic Materials, ASTM STP 1201, C.R. Brinkman, and S.F. Duffy, eds., American Society for Testing and Materials, Philadelphia, PA, 1994, pp. 390-408

Nemeth, N.N., et al.: Lifetime Reliability Evaluation of Structural Ceramic Parts With the CARES/Life Computer Program. AIAA Paper 93-1497, 1993.

Powers, L.M., et al.: Lifetime Reliability Evaluation of Monolithic Ceramic Components Using the CARES/Life Integrated Design Program. Proceedings of the American Ceramic Society Meeting and Exposition, Cincinnati, OH, April 19-22, 1993.

Nemeth, N.N., et al.: Designing Ceramic Components for Durability. Am. Cer. Soc. Bul., vol. 72, no. 12, Dec. 1993, pp. 59-69.

Nemeth, N.N., et al.: Durability Evaluation of Ceramic Components Using CARES/Life. ASME Paper 94-GT-362, 1994.

Janosik, L.M.A., et al.: NASA/CARES Dual-Use Ceramic Technology Spinoff

Applications. NASA TM-111694, 1994.

Salem, J.A., et al.: Reliability Analysis of Uniaxially Ground Brittle Materials. NASA TM-106852, 1995.

Anusavice, K.J., et al.: Stress and Reliability Analysis of a Metal-Ceramic Dental Crown. NASA TM-107178, 1996.